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Financial Predation by the 'Weak'

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Abstract

We examine a Stackelberg game where a financially constrained leader faces competition from a 'deep pocket' follower. We analyze the consequences of this trade-off between a financial and a strategic advantage for both the design of financial contracts and market structure. We derive conditions such that given that his competitor behaves as a Stackelberg leader, the follower, by targeting the incentive mechanism of the financial contract between the leader and his investor, can force the former to exit the market. We then design an anti-predation contract that is the optimal response to the threat of predation. In addition, using a numerical example we demonstrate that it is possible that the follower might produce a higher quantity than the leader.

JEL: G32, G43
Key words: Predation, Financial Contracts, Stackelberg Game.

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1 Introduction

There is plenty of research suggesting that financially constrained firms might be vulnerable to predation by cash rich competitors. Early work on the 'long-purse' or 'deep pocket' theory of predation, as this area of research is known, offers useful insights, however, it treats financial constraints as exogenous.[1] This is first recognized by Bolton and Scharfstein (1990) who develop a model where financial constraints emerge endogenously and then proceed to derive the optimal anti-predation contract. Faure-Gimauld (2000) builds on their approach by explicitly allowing for Cournot competition in the product market. In this paper, we follow their steps but we make one significant change in their framework. The financially constrained incumbent in our model is also a Stackelberg leader in the product market. Therefore, in our set up, the incumbent has a strategic advantage and the potential entrant has a financial advantage. We explore the consequences of this trade-off for the design of financial contracts and market structure.

As in Bolton and Scharfstein (1990) and Faure-Grimauld (2000), the source of agency problem in our model is lack of revenue verifiability. This implies that short-term contracts are not feasible since the borrower has always an incentive to default. However, in a multi-period setting the lender can condition any future funds on the firm's early performance and this might provide incentives to the firm to meet its financial obligations.[2] But what the entrant targets is exactly this incentive mechanism. The predation strategy amounts to sacrificing some short-term profits by producing a level of output that pushes the price sufficiently low so that the incumbent's revenues cannot match the repayment specified in the contract. Anticipating the reaction of the entrant, we then consider the optimal anti-predation contract. The intuition here is that the incumbent produces an output that is sufficiently low so that the entrant does not find anymore predation profitable. Using a numerical example, we also demonstrate that the incumbent, despite being a leader in the market, might produce a lower quantity than the entrant. This suggests that by observing only the output choices of firms without any knowledge of their financial position might be not sufficient for deducing the competitive structure of the industry that they belong..

Our results might also be relevant for the debate on whether or not a predator must be larger than its prey. While common sense suggests that larger firms have deeper pockets, this view has been challenged by Hilke and Nelson (1988) who develop a theoretical model that predicts that large diversified firms are more likely to exit in the face of predation than small firms unable to diversify. Their work is motivated by the *FTC v. General Foods* case where some members of the Federal Trade Commission argued

[1] See, for example, Telser (1966) and Benoit (1984).

[2] See Webb (1991) for another example where long-term contracts can mitigate agency problems.

that it is impossible for a smaller firm to induce the exit of a larger firm by following a predatory strategy. The intuition behind their result is that a large and diversified firm has already sunk search costs related to the entry in new markets. Therefore, withdrawing from one market and moving to another costs a large firm very little compared to a smaler and less diversified firm that faces a higher marginal cost of exit.[3]

Altough, we do not explicitly allow for differences in firm size, our model offers an alternative explanation for how larger firms can be victims of predatory behavior by smaller firms. As long as the incumbent firm is financially constrained, it will be vulnerable to a smaller firm with a deep pocket. Nevertheless, our results also suggest that, despite the entrant's predatory behavior, the lender can ensure that the incumbent survives by designing a financial contract that takes the threat into account.

Our paper is related to the extensive literature that examines the interaction between market structure and financial markets. A large body of work in this area focuses on the relationship between the choice of capital structure (debt to equity ratio) and output decisions in imperfectly competitive markets.[4] While the cases of Cournot and Bertrand competition have been studied extensively, to our knowledge, we are the first to consider the Stackelberg game. Our work is also related to a group of papers that examine how a variety of information and agency issues affect the design of financial contracts, output choices and the decisions to entry and exit the market. These include the signalling models by Gertner, Gibbons and Scharfstein (1988), Jain, Jeitschko and Mirman (2002) and Poitevin (1989, 1990), the managerial moral hazard models by Kanatas and Qi (2001) and Cestone and White (2003), and the signal jamming model by Jain, Jeitschko and Mirman (2004).

In the following section, we restrict our attention to the financial side of the model by considering the monopoly case. In section 3, we introduce a rival financially unconstrained firm and analyze the Stackelberg game. In section 4, we examine whether predation by the financially unconstrained follower is profitable. Given that predatory behavior is viable when the incumbent acts as a leader, in section 5, we design a financial contract that can deter predation. Finally, in section 7 we present a numerical example that demonstrates how the threat of predation can wipe-out the leader's strategic advantage.

[3]In contrast, Levy (1989) puts forward the opposite argument. Because a diversified firm has the flexibility of transferring assets internally it can improve their marginal efficiency. Then these assets play the same role as excess capacity that can deter any potential entrant.

[4]See, for example, Brander and Lewis (1984), Maksimovic (1988), Glazer (1991), Jain, Jeitschko and Mirman (2003), Lambrecht (2001), McAndrews and Nakamura (1992), Snowalter (1995) and Wanzenried (2003).

2 Single Seller

We first solve the monopoly case before we introduce a second producer that will allow us to consider strategic interactions. By doing so we can concentrate on the financial contract design problem. We refer to this monopolist as the incumbent (i). There are two production periods ($t = 1, 2$). Each period the cost of producing one unit of output is $c > 0$. There is demand uncertainty in the product market and to keep things simple we assume that there are two states ($s = h, l$) of the world. In the high demand state the incumbent faces the inverse demand curve $p_t(q_{it}) = a - q_{it}$ where q_{it} denotes output produced in period t by the incumbent and a is a positive constant. In the low state we assume that the demand vanishes. The incumbent chooses output to maximize expected profits prior to the revelation of the true demand state.

Assumption 1:

$$s_t = \begin{cases} h & \text{with probability } \theta \\ l & \text{with probability } 1-\theta \end{cases},$$

We assume that s_1 and s_2 are inependently distributed.

There is asymmetric information in the product market.

Assumption 2: *The state of the demand is revealed only to the incumbent. All other parameters are public knowledge that are also observed by the investors and any third party.*

On the financial side of the model, the incumbent needs to raise external funds to finance production costs. We assume that the incumbent has no initial wealth and that all first period profits are used for consumption. External funds can be raised in the capital market. The capital market consists of a large number of risk-neutral investors. We assume that capital markets are perfectly competitive and without any loss of generality we set the opportunity cost of funds to zero.

Given that, following Assumption 2, investors cannot observe the state of demand the terms of the loan contract between an investor and the incumbent cannot be contingent on profits. When the incumbent cannot meet obligations specified in the contract, the investor can force the termination of the project.

Let q_i^* denote the expected profit maximizing output, p^* the correspondind price and V^* revenues in the high demand state (notice that the corresponding revenues in the low demand state are equal to 0). Then

$$q_i^* = \frac{a - c/\theta}{2} \tag{1}$$

$$p^* = \frac{a + c/\theta}{2} \tag{2}$$

and

$$V_i^* = (a - q_i^*)q_i^* = \frac{a^2 - (c/\theta)^2}{4} \tag{3}$$

Each period the incumbent needs to borrow cq_i^* from the investor to finance his production

Assumption 3:

$$\theta V_i^* > cq_i^*$$

Assumption 3 guarantees that investing in the incumbent's firm is ex ante profitable.

First, we consider the case where there is only one period. Let Z denote the loan repayment in the high demand state. At the beginning of the first period, the incumbent borrows cq_i^* from the investor. Since the state of demand is not observable by outsiders, investors must rely on the incumbent to report the true state. However, when there is only one period the incumbent will always report that the state is low since his payoff in the high demand state when he reports truthfully is equal to $V_i^* - Z$ while his payoff when he lies is equal to V_i^*. When there is only one period, the incumbent does not care about termination.[5] It is clear that in a static environment, the investor has no intention to finance the incumbent.

Things work differently in a dynamic environment. In the two period case, the investor can pursuade the incumbent to reveal his true profits in the first period. The reason is that in the two-period case termination is costly because the incumbent loses any second period profits. The investor can condition any additional finance in the second period on the first period performance. That is, if in the first period the incumbent reveals that the demand is low then the investor terminates the project. On the other hand, if the incumbent reports that the demand is high and makes a sufficiently high repayment the investor will grant another loan for the second period production. The *threat of termination* induces the incumbent to reveal the true state in the first period. Notice that the threat of termination is credible in the first period but not in the second one. Since the model ends at the end of the second period, the threat is no longer credible and the incumbent will choose to report that the demand is low no matter what the true state of the demand is.

[5] We have implicitly assumed that the incumbent is protected by limited liability. See Carr and Mathewson (1988) and Lawarrée and Van Audenrode (1996) for the case of unlimited liability.

2.1 Optimal Contract

Perfect competition in the capital market implies that the investor's ex ante profits must be equal to zero

$$-cq_i^*(1+\theta)+\theta Z=0 \tag{4}$$

The incumbent borrows the amount cq_i^* at the beginning of the first period. With probability θ the market demand is high, the incumbent repays Z and the investor provides a second period loan. However, if the demand turns out to be low, the project is terminated. Therefore, refinance is conditional on the incumbent's first-period behavior. When the incumbent repays Z, a second period loan of size cq_i^* is granted. At the end of the second period the threat of termination is no longer credible. The incumbent has an incentive to deceive the investor and refuses to repay anything. The investor terminates the project with certainty.

Rearranging the zero-profit condition (4), we get an expression for the repayment Z

$$Z=\frac{1}{\theta}cq_i^*(1+\theta) \tag{5}$$

The repayment (5) must induce the incumbent to report the state truthfully. The corresponding incentive compatibility condition is

$$V_i^*-Z+\theta V_i^*>V_i^* \tag{6}$$

The LHS of (6) captures the incumbent's total payoff conditional on a truthful report in the first period when the demand is high in which case the investor will also provide funds in the second period. The RHS is the benefit from deceiving the investor when the demand is high in the first period. The incentive constraint (6) sets an upper limit for the repayment (5)

$$Z\leq\theta V_i^* \tag{7}$$

Notice that if the above constraint is satisfied then the limited liability constraint $Z\leq V_i^*$ is also satisfied.

3 Introducing Competition

In this section, we introduce a second firm into the model. Now, the incumbent firm faces a potential entrant. We investigate the effect of entry on the contractual relationship between the investor and the incumbent. In general, an incumbent might be able to deter the threat of entry by expanding his output capacity or by following an aggressive output strategy. Here, we assume that the incumbent is not in the position to deter entry. Investment in capacity expansion is a sunk cost which is irreversible. Aggressive output strategies reduce the incumbent's short-term profits. Both of these strategies require a significant amount of financial resources and the incumbent in our model is financially constrained. The incumbent is lacking the funds neccessary for pursuing such expensive entry deterrence policies.

Outside investors might also be reluctant to finance such strategies. To see this, consider what happens when potential entry takes place in the second period. The above strategies imply that the incumbent will have to borrow more from the investor in the first period. To successfully block entry, the size of the first-period loan would have to increase which implies a higher first-period repayment. However, this could violate the incentive compatibility constraint and in that case the contractual relationship between the investor and the incumbent would break down.

We therefore consider the situation where the incumbent accomodates the entrant. We assume that the entrant is a Stackelberg follower who is not financially constrained. Therefore, the entrant has a financial advantage but the incumbent has a strategic advantage. We explore the implications of this trade-off for both market structure and the relationship between outside investors and the incumbent. We assume that entry takes place in the first-period after the incumbent signs the financial contract. In this section, we derive the market equilibrium for each period and the finacial contract between the incumbent and the investor restricting our attention to startegic considerations only in the output market. In this case, the two competitors are involved in a Stackelberg game during the first period. When the demand is low, the incumbent will be denied second-period finance and the entrant will become a monopolist in the second period. In the following section, we are going to consider the case where the entrant can use a predation strategy in the first period that exploits the financial relationship between the incumbent and the investor, in order to establish himself as a monopolist. Finally, assuming that predation is the optimal response to the original contarct, we examine whether the incumbent and the investor can design an anti-predation contract that will allow the former to survive in the market.

3.1 The Stackelberg Game

We use the subscript (e) to denote the entrant. With two competitors the matket (inverse) demand in the high state is $p_t(Q_t) = a - Q_t$, where $Q_t = q_{it} + q_{et}$. In period 1, the incumbent and the entrant play a leader-follower quantity game. The incumbent learns about the threat of entry prior to the signing of the financial contract. To derive a complete solution of the model, we first derive the entrant's optimal reaction. In the first period, the entrant acts as a Stackelberg follower choosing his level of output q_{e1} given the incumbent's choice q_{i1}. In the second period, there is a chance for the entrant to become a monopolist in the market. If the market demand is low in the first period, the incumbent will fail to meet his contractual agreement with the lender who in turn will deny any second-period finance; i.e. the incumbent's project is terminated. Then, the entrant will become a monopolist with probability $1-\theta$. However, when the first period demand turns out to be high, a second period loan is granted to the incumbent. In this situation, the entrant remains a Stackelberg follower. This will happen with probability θ. Let Π_i and Π_e denote the total expected profit of the incumbent and the entrant, correspondingly. In addition, denote by π_{it} and π_{et} the expected profits in period t for the incumbent and the entrant, respectively.

The entrant solves the following problem.

$$\begin{aligned} \max_{\{q_{e1},q_{e2},q_{m2}\}} \Pi_e &= \theta(a-Q_1)q_{e1} - cq_{e1} + \theta^2(a-Q_2)q_{e2} - \theta c q_{e2} \\ &\quad + (1-\theta)\,\theta(a-q_{m2})q_{m2} - (1-\theta)\,cq_{m2} \end{aligned} \tag{8}$$

where q_{m2} denotes the level of output produced by a monopolist. The entrant's reaction functions for each of the two periods and his optimal quantity as a monopolist are given by:

$$q_{et}(q_{it}) = \frac{a - q_{it} - c/\theta}{2}; \quad \forall t \tag{9a}$$

$$q_e^m = \frac{a - c/\theta}{2}. \tag{9b}$$

Now, consider the incumbent's output selection problem. His profit's maximisation problem can be written as:

$$\begin{aligned} \max_{\{q_{i1},q_{i2},\}} \Pi_i &= \theta[(a - q_{i1} - q_{e1}(q_{i1}))q_{i1} - \bar{Z}] + \\ &\quad \theta^2(a - q_{i2} - q_{e2}(q_{i2}))q_{i2} \end{aligned}$$

where $\bar{Z}$ denotes the first-period repayment. Following the same steps as in the previous section we find that the repayment must satisfy

$$\bar{Z} = \frac{1}{\theta}[cq_{i1} + \theta c q_{i2}]$$

Substituting the above expression in the incumbent's problem we get

$$\begin{aligned} \max_{\{q_{i1},q_{i2},\}} \Pi_i &= \theta(a - q_{i1} - q_{e1}(q_{i1}))q_{i1}) - cq_{i1} + \\ &\quad \theta^2(a - q_{i2} - q_{e2}(q_{i2}))q_{i2} - \theta c q_{i2} \end{aligned} \tag{10}$$

Thus, as long as the repayment satisfies the incentive compatibility and individual rationality constraints, which we assume that it does, the financial constraint does not affect the optimal quantity choices. The F.O.C.s yield the following solutions

$$q_{it}^{**} = q_i^{**} = \frac{a - c/\theta}{2}, \quad \forall t \tag{11}$$

Substituting the above solution into the entrant's reaction function we get his optimal response

$$q_{et}^{**} = q_e^{**} = \frac{a - c/\theta}{4}, \quad \forall t \tag{12}$$

Next, we derive and compare expected profits. Substituting q_i^{**}, q_e^{**}, and q_e^m into the objective functions, we obtain

$$\Pi_i^{**} = \pi_{i1} + \theta\pi_{i2} = \frac{1}{8}(1+\theta)\theta\left(a - \frac{c}{\theta}\right)^2 \tag{13}$$

$$\begin{aligned} \Pi_e^{**} &= \pi_{e1} + \theta\pi_{e2} + (1-\theta)\pi_e^m = \\ &\frac{1}{16}(1+\theta)\theta\left(a - \frac{c}{\theta}\right)^2 + \frac{1}{4}(1-\theta)\theta\left(a - \frac{c}{\theta}\right)^2 \end{aligned} \tag{14}$$

Notice that the incumbent earns Stackelberg leader (expected) profits with certainty in the first period and with probability θ in the second period. In contrast, the entrant in each of these cases earns Stackelberg follower profits but also earns monopoly profits with probability $1-\theta$ in the second period.

By inspection of π_i^{**} and π_e^{**}, we find that if the probability of the high demand state is low, the expected profit of the entrant can be higher than the incumbent's because there is a good chance that the incumbent, in the second period, will be out of the market and the entrant will enjoy monopoly profits. As the probability of the high demand state increases it is more likely that the incumbent will obtain new funds in the second period and hence there is a lower chance that the entrant will become a monopolist. To be precise if $\theta > \frac{3}{5}$ then $\Pi_i^{**} > \Pi_e^{**}$.

To summarise, at the beginning of the first period, the lender offers the incumbent a contract demanding a repayment $\bar{Z}$ in exchange for a loan cq_i^{**}. If, at the end of the first-period, the repayment is not made the lender will terminate the project. In contrast, if the repayment is made then the lender will offer another loan of the same size. Observe that the relationship between the lender and the incumbent that is specified in the contract signed before the beginning of the production in the first period depends on the entrant's anticipated action. Up to this point, the entrant's output decision affects the incumbent's output and profit only because of strategic considerations in the product market that have an influence on the first period repayment and thus on the incentives of the incumbent to repay the loan. In the next section, we will show how the entrant can directly influence the contractual relationship between the incumbent and the lender.

4 Predation

We mentioned in the last section that the entrant might be able to exercise some influence over the loan contract between the lender and the incumbent by following a 'predation strategy'. The idea behind this strategy is that a firm sacrifies its short term profit in order to drive out its rivals and take control of the product market in the long run. The goal of predation is to allow the firm to enjoy a monopoly profit in the future by eliminating competitors from the market. Actually, if such strategy is viable then the incumbent (and his investor) will anticipate it and will be forced to stay out of the market even in the first period.

In our setup, the incumbent is fully leveraged while the entrant is self-financed. Now, assuming that the incumbent acts as a leader in a Stackelberg game, the entrant might find it profitable to produce a level of output in the first period that it is higher than a follower's optimal response. By doing so, the price amd hence revenues in the high demand state of both competitors will be suppressed and the incumbent might not be able to make the repayment. In that case, the entrant will become a monopolist. In this section, we examine under what conditions predation is viable while in the next section we will investigate whether, given that predation is viable, the incumbent and the investor can design a contract that would allow the incumbent to survive.

Thus, our goal in this section is to find if it is profitable for the entrant to increase his production to the point that it drives the incumbent's revenues slightly below the first period repayment specified in the contract.[6] Let π_e^f, π_e^p and π_e^p denote the entrant's profit from being a follower, from predating, and from being a monopolist, respectively. Then, the predation strategy is a dominant strategy for the entrant when

$$\pi_e^p + \pi_e^m > (1+\theta)\pi_e^f + (1-\theta)\,\pi_e^m$$

or

$$\pi_e^m > \frac{1}{\theta}\left((1+\theta)\pi_e^f - \pi_e^p\right) \tag{15}$$

[6]Note that the incumbent's financial constraint does not affect his level of output. Therefore, the entrant does not learn anything from the incumbent's choice of output. Here, we assume that the incumbent's wealth is public knowledge. Thus, the entrant by observing the incumbent's level of production can deduce the terms of the contract.

If the incumbent acts as a leader, he will sign a contract that offers a first-period loan of size cq_i^{**}, sets the first-period repayment $\bar{Z}$ equal to $\frac{1}{\theta}[(1+\theta)cq_i^{**} - K]$ and if the incumbent makes the repayment the lender will offer a second-period loan also of size cq_i^{**}. Our next step, is to find the quantity that the entrant needs to produce, q_e^p, so that the incumbent's first-period revenues are equal to $\bar{Z}$. Put differently, q_e^p is the solution of the following equation

$$(a - q_i^{**} - q_e^p)q_i^{**} = \frac{1}{\theta}(1+\theta)cq_i^{**}$$

Solving for q_e^p we get

$$q_e^p = a - q_i^{**} - \frac{1+\theta}{\theta}c \tag{16}$$

For the predation strategy to be successful inequality (15) must be satisfied, i.e. the following must be true

$$\begin{aligned} & (\theta(a - q_e^m) - c)q_e^m \\ > \; & \frac{1}{\theta}\left[(1+\theta)(\theta(a - q_i^{**} - q_e^{**}) - c)q_e^{**} - (\theta(a - q_i^{**} - q_e^p) - c)q_e^p\right] \end{aligned}$$

If this inequality is not satisfied then the entrant will act as a follower in the first period. Furtermore, if the state of demand in the first period is high then the entrant will also be a follower in the second period, otherwise, the incumbent will exit the market and the entrant will be the sole producer. In contrast, if the inequality is satisfied then should the incumbent decide to act as a leader in the first-period then the entrant will follow the predation strategy. In this section, we have assumed that the incumbent has not anticipated this behavior and as a result will be unable to make the repayment and will have to exit the market. In the following section, we examine the incumbent's options when the predation strategy is both viable and correctly anticipated.

5 Anti-Predation Contract

When inequality (15) is satisfied the long-term contract between the incumbent and the investor that is designed under the supposition that the former will be a leader in the product market is not predation-proof.[7] When the financial position of the incumbent is common knowledge, rival firms can expolit this weakness by pursuing a strategy such that the incumbent is forced out of competition. The predation strategy that we have derived in

[7] Put differently, the equilibrium is not sub-game perfect.

the previous section does not target directly the incumbent's product market decision. *What the entrant's predation output choice does is to adversely affect the financial relationship between the incumbent and its financier by tampering with the incentive mechanism of the financial contract.*

The intuition behind an anti-predation contract is as follows. The lower the output that the incumbent produces the more unprofitable the entrant's predation strategy becomes. To see this, consider what happens as the incumbent's output vanishes. If the entrant decides to act as a follower his first-period profits will be approximately equal to monopoly profits while if he decides to predate his first-period profits will be much lower. In either case, his second-period profits will be (approximately) equal to monopoly profits. Given that when the entrant acts as a follower, the incumbent's profits are increasing in his own quantity in order to solve for the optimal anti-predation contact we need to find the highest output that the incumbent can produce such that the entrant is indifferent between being a follower and following the predation strategy.

Let $q_e^p(q_i)$ denote the entrant's optimal response when he follows the predation strategy and the incumbent produces q_i in the first period and $q_e^f(q_i)$ denote the entrant's optimal response when he behaves as a follower in the first-period. Then, from (16),

$$q_e^p(q_i) = a - q_i - \frac{1+\theta}{\theta}c \tag{17}$$

and from (9a),

$$q_e^f(q_i) = \frac{a - q_i - c/\theta}{2} \tag{18}$$

Then using (15), the optimal anti-predation output level, $\hat{q}_i$,[8] can be found by solving the following equation:

$$\pi_e^m = \frac{1}{\theta}\left(\pi_e^f(q_e^f(\hat{q}_i), \hat{q}_i) + \theta\pi_{e2}^f(q_i^{**}, q_e^{**}) - \pi_e^p(q_e^p(\hat{q}_i), \hat{q}_i)\right) \tag{19}$$

where $\pi_e^f(q_e^f(\hat{q}_i), \hat{q}_i)$ and $\pi_e^p(q_e^p(\hat{q}_i), \hat{q}_i)$ denote the entrant's first-period profits when he acts as a follower and when he uses the predation strategy, respectively. The term $\pi_{e2}^f(q_i^{**}, q_e^{**})$ represents the entrant's profit as a follower in the second period. Notice that since the model ends at the end of the second period, the entrant does not have an incentive to pursue the predation strategy during that period.

The above solution implies that the lender will ask for a repayment $\hat{Z}$ that, given first period revenues $\hat{V}_i$, must satisfy the following incentive

[8] This is the optimum quantity, because we have, without any loss of generality, implicitly assumed that if the entrant is indifferent between behaving as a follower and predating he chooses the former.

compatibility constraint

$$\hat{V}_i = (a - \hat{q}_i - q_e^f(q_i))\hat{q}_i \leq \frac{1}{\theta}c(\hat{q}_i + \theta q_i^{**}) = \hat{Z} \tag{20}$$

6 Numerical Example

In this section, using a numerical example we illustraye the derivation of the optimal anti-predation contract. We specify the following parameter values: $a = 400$, $\theta = 1/2$, and $c = 15$.

Once more, we begin with the case when there is only one firm. It is straightforward to show that $q_i^* = 185$ with corresponding single-period monopoly profits $\pi^m = 17,112.5$. In addition, $Z = 8,325 < 19,887.5 = \theta V_i^*$; i.e. the incentive compatibility condition is satisfied.

Next, we consider the case where the entrant behaves as a follower. In this case we have the following solution: $q_i^{**} = 185$, $q_e^{**} = 92.5$, $\Pi_i^{**} = \pi_{i1} + \frac{1}{2}\pi_{i2} = \frac{3}{2}8,556.25 = 12,834.375$, $\Pi_e^{**} = \pi_{e1} + \frac{1}{2}\pi_{e2} + \frac{1}{2}\pi^m = \frac{3}{2}4,278.125 + 8.556.25 = 14,973.4375$. We also have $\bar{Z} = Z = 8,325 < 11,331.25 = \theta V_i^{**}$; again the incentive compatibility condition is satisfied.

Our next step, is to calculate the entrant's predation output, q_e^p, given that the incumbent behaves as a leader; i.e. the later produces $q_i^{**} = 185$. From (16) we have that $q_e^p = 170$. If the entrant produces this level of output then the incumbent's first-period revenue will be equal to the repayment, i.e. $(a - q_i^{**} - q_e^p)q_i^{**} = \bar{Z} = 8,325$. Thus, the entrant by producing slightly above that output level can push the incumbent out of the market as the latter will be unable to meet his contractual obligations.

It is interesting to compare the above solution, with the one obtained under the supposition that the entrant predates when the incumbent is not financially constrained. In this second case we find the predation output $\tilde{q}_e$ by setting the incumbent's profits equal to zero. It is clear that, given the linear demand curve, $\tilde{q}_e = 185$; i.e. the aggregate output is equal to the perfectly competitive output. Notice that $q_e^{**} < q_e^p < \tilde{q}_e$. *The predation strategy by targeting the incumbent's incentive compatibility constraint results in a less 'aggressive' output strategy than a conventional predation strategy.*

For the predation strategy to be pursued it has to be profitable. That is inequality (15) must be satisfied. Substituting $\pi_e^p = 1,275$, $\pi_e^f = 4,278.125$, and $\pi_e^m = 17,112.5$ in (15) we find that the inequality is indeed satisfied. Also note that the entrant's expected total profits are equal to $\Pi_e^p = 18,387.5$.

Finally, we derive the optimal anti-predation output and the associated optimal financial contract. The incumbent can deter the entrant's predation strategy by choosing a lower level of output that reduces the incentives of the entrant to follow that startegy. Solving (19) we find that $\hat{q}_i = 113.422$. Substituting this solution in (17) and (18) we find that $q_e^p = 241.578$ and

$q_e^f = 128.289$. The first level of output is equal to the level of output that the entrant would produce had he followed the predation strategy while the second level of output is the one he will produce behaving as a follower. In either case his expected total profits will be equal to $\hat{\Pi}_e = 18,924.3$. The corresponding profits for the incumbent are equal to $\hat{\Pi}_i = 11,553.5$. Lastly, using (20) we find that the repayment is equal to $\hat{Z} = 8,252.66$ which is less than first-period revenues $\hat{V}_i = 17,953.5$ that implies that the incentive compatibility constraint is satisfied.

It is interesting to note that in the above numerical example the equilibrium output level of the entrant is higher than the incumbent's. The entrant by exploiting the incumbent's financial vulnerability has managed to wipe out th latter's strategic advantage.

7 Conclusion

The central theme of this paper is that a financial disadvantage may wipe out any strategic advantage in the product market. The reason is that financial vulnerability offers incentives to rival firms to follow predatory behavior. As in Bolton and Scharfstein (1990) the goal of predation is not to convince competitors that it is unprofitabel to stay in the market but to target their relationship with their financiers and push them towards bankruptcy.

The predatory behavior of the entrant involves a high output level that sufficiently reduces the price, and hence revenues, so that it induces the incumbent to strategically default on his financial obligations. An appropriately designed financial contract can deter predation. The incumbent by lowering his own output decreases the profitability of the predation strategy. From the incumbent's point of view, given that predation is viable when he behaves as a Stackelberg leader choosing the predation deterrence contract is the only way to survive. Given the incumbent's action, the strategy that gives the entrant the highest return is to be a Stackelberg follower.

An interesting consequence is that although the outcome of the game is a Stackelberg-Nash equilibrium, the incumbent, as the quantity leader, might produce and profit less that the entrant. The result contrasts the usual outcome of the Stackelberg game in which the financial position of firms is not taken into account.

Agency problems play an important role in formulating business strategies. Leveraged firms find it easy being targeted from deep-pocket rivals. Our model suggests that even large firms might become victims of predation if they are financially constrained. In order to survive in the market, the incumbent has to be 'soft' in the product market so that it does not provoke an aggressive output strategy from his competitors.

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